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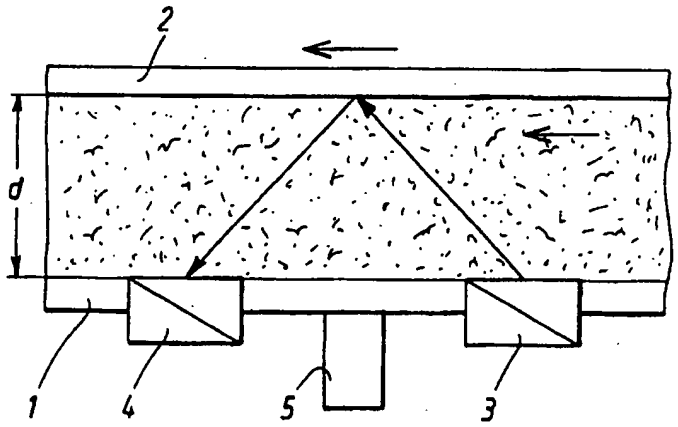
(54) Title: METHOD FOR MEASURING THE CONCENTRATION OF CELLULOSE MATERIAL IN A WATER SUSPENSION DURING BEATING OF WOOD CHIPS AND ARRANGEMENT FOR PERFORMING THE METHOD

(57) Abstract

The invention relates to a method for measuring for the concentration of cellulose material in a water suspension during beating of wood chips. The method is characterized in that the measuring is performed during the beating process itself by means of the phase displacement of microwaves in relation to a reference curve during the penetration by the microwaves of a certain distance in the suspension.



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TITLE: Method for measuring the concentration of cellulose material in a water suspension during beating of wood chips and arrangement for performing the method.

TECHNICAL FIELD:

The present invention relates to a method for measuring the concentration of cellulose material in a water suspension and/or steam suspension when beating wood chips and the invention comprises an arrangement for performing the method. The invention is particularly related to beating wood chips in a refiner, preferably a disc refiner.

PRIOR ART:

When wood chips are beaten in a refiner for the production of cellulose fibres, the wood chips are fed in a water suspension in between two usually vertical discs which rotate in relation to each other and which carry out the actual beating. The flow of medium between the discs occurs from the centre and out towards the periphery. Also other kinds of refiners comprising a cone which rotates within a second cone are known. These and other types of refiners are known within the cellulose industry.

To achieve a desired result of the beating, it is necessary that the decisive parameters in the beating process can be regulated in the desired way. These parameters are, according to prior art, the feed velocity of chips/pulp suspension and the concentration of chips/pulp therein, the distance between the beating discs which influences the pressure of the pulp suspension between the discs, the temperature in the pulp suspension during different stages of the beating process, the rotation speed of the beating discs in relation to each other, etc. To be able to

regulate the beating process depending on these different parameters, preassure and temperature sensors have been arranged, according to the prior art, in one of the beating discs along its radius. These sensors may be arranged in a radial row or be radially displaced in relation to each other and be screwed into or in some other way secured in one of the beating discs or the back piece in which the discs are fastened. They can also be arranged on a radial bar which is mounted on or between the beating segments. The electric wires which must go from the sensors to some indicating apparatus or computer are usually collected in a cable on the rear side of one of the beating discs. Such arrangements are for example described in the American patent specification 4148439 and the international patent application WO 96/14156 as well as the Swedish patent 9701625-7.

A further factor which contributes to the quality of the refined pulp is the concentration of the pulp during the grinding process. However, no such continuous measurement of this concentration has been carried out previously in industrial context. The concentration has been measured only after the refining has been completed.

THE TECHNICAL PROBLEM:

The measuring of the above-mentioned parameters and the equipment for this measuring has functioned well but to give a complete picture of the beating process it is also necessary to measure the concentration of the cellulose fibre pulp along the route of the pulp through the beating equipment. This concentration has previously been measured after the completed refining process, i.e. outside the refiner, but this measurement has therefore only been a control measurement since at this stage the refinement of the pulp has been completed. Measurement of the concentration of the cellulose-containing material in the

suspension at different stages during the refinement has turned out to be very difficult and it has not been possible to carry out this measurement by known methods.

THE SOLUTION:

It has therefore for long been a desire to be able to carry out such a concentration measurement and according to the present invention a method for measuring the concentration of cellulose material in a water suspension during beating of wood chips has been obtained, which method is characterized in that the measurement is carried out during the beating process itself by means of the phase displacement of microwaves in relation to a reference curve during the penetration by the microwaves of a certain distance in the suspension.

According to the invention, it is suitable that the frequency of the microwaves is preferably 5-25 GHz, suitably 5-10 GHz.

According to the invention, the pulp concentration should lie in the region 2-50 weight percent, typically 35-45 weight percent.

According to the invention, the measurement is suitably carried out during the beating in a refiner.

The measuring of the concentration in a refiner should, according to the invention, be combined with measuring of the distance between the beating discs and measuring of the electrical conductivity in the suspension, as well as the temperature. The temperature and dielectricum are used to compensate for changes.

The invention also comprises an arrangement for performing a method for measuring the concentration of cellulose

material in a water suspension during beating of wood chips, which arrangement is characterized by a transmitting antenna for transmitting microwaves through the suspension of cellulose material, a receiver antenna for receiving the transmitted microwaves at a certain distance from the transmitting antenna and an electronic unit comprising a generator for producing microwaves and a detector for detecting the phase displacement of the microwaves that have passed through the suspension in relation to a phase curve for microwaves which have penetrated a reference suspension with known concentration, and which arrangement is characterized in that the transmitter and the receiver antennas are arranged on a radial bar in one of the beating discs in a refiner.

According to the invention, it is suitable that the bar on that side which faces the pulp is wave- or sawtooth-shaped and that the transmitter antenna is arranged in an inward bend with the main ray directed towards the opposing beating disc in such a way that the reflection therefrom passes over the nearest outward bend in relation to the transmitter atenna and hits the receiver antenna at a point further away, so that the leakage of microwaves is hindered by the nearest outward bend. According to the invention the transmitter and receiver antennas can also be arranged directly opposite each other on each beating disc.

It is also suitable according to the invention that the arrangement comprises a distance gauge for measuring the distance between the beating discs and possibly a gauge for measuring the conductivity for electric current in the suspension.

FIGURE DESCRIPTION:

The invention will in the following be described more in detail with reference to the enclosed drawings in which:

Fig. 1 schematically shows the arrangement of the sensors according to a first embodiment of the invention, in which

Fig. 2 shows the arrangement of the sensors and a distance gauge according to a second embodiment of the invention, and where

Fig. 3 shows an embodiment of the invention similar to the one i Fig. 2.

DETAILED DESCRIPTION:

The measurement of the concentration according to the present invention depends on the fact that the dielectric constant for a suspension of the kind in question changes with the concentration of cellulose-containing material in the suspension. Therefore, when microwaves are transmitted from one antenna and are to be received by another antenna, which microwaves shall penetrate the suspension, it will take different lengths of time for the waves to spread out and reach the receiver antenna for different concentrations. This is shown if a phase curve is drawn up wherein it can be seen that the phase curve for a dispersion having a certain concentration is displaced in relation to the phase curve for a second concentration or for pure water or steam. According to the present invention, a phase diagram for microwaves with zero concentration of cellulose-containing material is initially drawn up and thereafter a corresponding phase curve for a water suspension and/or steam suspension containing cellulose-containing material is drawn up, and the phase displacement is measured. Different concentrations have different phase displacement and reference curves which show known concentrations can therefore be drawn up and compared with curves for concentrations which are to be measured.

The phase curves can be influenced by and are dependent on many factors, for example the construction of the apparatus, but the phase displacement can nevertheless be measured accurately by first drawing up a reference curve for only steam, which reference curve automatically appears at the start when only steam flows through the apparatus. Other factors which are significant to the form of the curve are the distance between the beating discs, leakage or damping of the microwaves and the electric conductivity in the suspension.

Fig. 1 shows schematically an embodiment of the invention in a disc refiner. A stationary disc 1 and a rotating disc 2 are arranged opposite each other. The discs are seen from above and the disc rotates in the direction shown by the arrow. The distance d between the discs is in the region of 0,2-1 mm. Between the discs a water suspension of cellulose-containing material the concentration in which of this material is to be measured is present. At a desired point on the stator 1 one or more transmitter antennas 3 with a radiation direction towards the rotating disc 2 is (are) mounted. On the rotating disc 2 a receiver antenna 4 is arranged, which of course can also be several in number. It is possible to mount transmitter and receiver antennas in the opposite way. In the present case, the microwaves radiate in the direction shown by the arrow from the transmitter antenna 3 to the receiver antenna 4 and are registered in a not shown electronic unit as described above. This is a simple embodiment of the present invention but since the transmitter and receiver antennas are each arranged on a separate beating disc, a slip ring for the electrical connection must be arranged on the rotating disc.

The transmitter and receiver antennas 3 and 4 may be of a conventional type but are preferably so-called microstrip antennas which are described in the Swedish patent 9504520-0. In the figure the antennas 3 and 4 are shown only by symbols.

The temperature which exists between the discs 1 and 2 is usually between 150-200°C often 170-180°C and the pressure is a number of bars, for example 6 bars.

The concentrations which it is suitable to measure according to the present invention are in the area of 10-50 weight percent, usually 35-45 weight percent.

The frequency of the microwaves should suitably be below 25GHz and they are preferably in the range of 5-10 GHz. The reason for choosing this frequency range is that at higher frequencies the costs for the measuring instrument are increased.

According to the invention, it is suitable that the receiver and transmitter antennas are arranged at the radially outer parts of the beating discs since measuring of the concentration before the so-called pressure peak, i.e. in the central parts of the refiner where chips and water are fed in, usually is of less interest.

Fig. 2 shows a second embodiment of the present invention where both the transmitter antenna 3 and the receiver antenna 4 are arranged on the stator 1. To make it possible for the receiver antenna 4 to receive any signals from the transmitter antenna 3, it is therefore necessary that the signals are reflected from the rotating disc. In this way, a longer route for the microwaves to go through the suspension is also obtained, which gives a more distinct phase displacement. The drawing also shows a distance gauge

5 which measures the distance d between the discs. This distance gauge 5 may also be of a conventional kind and is suitably a magnetic gauge of a known kind. The distance measurement is then carried out by means of a permanent magnet which is attached to the rotating part and a coil on the stationary part. Changes in the magnetic field are detected in a suitable way. The signals from the distance gauge are directly proportional to the distance between the discs 1 and 2. Such a magnetic distance gauge is suitable in that the temperature is high and the environment generally is difficult for electronic measuring. In those cases where conventional distance measuring already exists in the beating zone this can possibly be used. However, it should be noted that such a method does not solve the local distance measurement since the distance between discs does not necessarily have to be the same along the radius.

Fig. 3 shows how the transmitter antenna 3 and the receiver antenna 4 can be mounted on a bar 6 which is arranged on the stator 1. This bar 6, which is partly countersunk in the stator 1, is shown somewhat exaggeratedly protruding therefrom. Besides the transmitter and receiver antennas 3 and 4 for microwaves, the bar 6 can also include sensors for measuring pressure, temperatures, etc. It is described in the Swedish patent 9701625-7. The advantage with arranging the transmitter and receiver antennas 3 and 4 on this bar is that the leakage of microwaves which spreads out can be minimized by arranging the transmitter antenna 3 on a sloping side of the arc- or sawtooth-shaped bar 6 and by mounting the receiver antenna 4 on another wave or a hack which slopes towards the slope where the transmitter antenna 3 is arranged and on a slope which does not lie closest to this. When the ray from the transmitter antenna 3 to its main part is directed in a suitable way towards the rotating disc 2 so that the reflection of the ray hits the receiver antenna 4, then the weaker leakage of the

microwaves will hit the projection between the sides which slope towards each other and have the antennas 3 and 4 and consequently reduce the disturbances to the receiver antenna 4.

Through the present invention a method and an arrangement for measuring in a continuous and simple way the concentration of a material dispersed in a liquid or steam have been brought about. This is of great importance for pulp production in a refiner since the concentration is one of the parameters for achieving a desired quality of the pulp. The concentration which rises along the radius of the beating discs represents weight percent celluloseicontaining material in relation to water. This water exists mostly in the form of steam close to the saturation point but may also probably exist in the form of liquid and then mostly bound in the fibres.

The invention is not limited to the embodiment examples shown and it can be varied in different ways within the scope of the claims.

CLAIMS:

1. Method for measuring the concentration of cellulose material in a water suspension during beating of wood chips, c h a r a c t e r i z e d in that the measuring is performed during the beating process by means of the phase displacement of microwaves in relation to a reference curve during the penetration by the microwaves of a certain distance in the suspension.

2. Method according to claim 1, c h a r a c t e r i z e d in that the frequency of the microwaves preferably is 5-25 GHz, suitably 5-10 GHz.

3. Method according to claim or 1 or 2, c h a r a c t e r i z e d in that the pulp concentration is in the range of 2-50 weight percent, typically 35-45 weightpercent.

4. Method according to any one of claims 1-3, c h a r a c t e r i z e d in that the measuring is carried out during beating in a refiner.

5. Method according to claim 4, c h a r a c t e r i z e d in that the measuring of the concentration is combined with measuring of the distance between the beating discs and the electrical conductivity in the suspension as well as the temperature.

6. Arrangement for performing a method for measuring the concentration of cellulose material in a water suspension during beating of wood chips comprising a transmitter antenna (3) for transmitting microwaves through the suspension of cellulose material, a receiver antenna(4) for receiving the transmitted microwaves and an electronic unit comprising a generator for producing the microwaves and a detector for detecting the displacement of the microwaves

that have passed through the suspension in relation to a phase curve for microwaves which have passed through a reference suspension with known concentration,
c h a r a c t e r i z e d in that the transmitter and receiver antennas (3, 4) are arranged on a radial bar (6) in one of the beating discs (1, 2) in a refiner.

7. Arrangement according to claim (6),
c h a r a c t e r i z e d in that the bar (6) on that side which faces the pulp is wave- or sawtooth-formed and that the transmitter antenna (3) is arranged in an inward bend with the main ray directed towards the opposing beating disc so that the reflection therefrom passes over the nearest outward bend in relation to the transmitter antenna (3) and hits the receiver antenna (4) at a point further away so that leakage of microwaves is hindered by the nearest outward bend.

8. Arrangement according to claims 6 or 7,
c h a r a c t e r i z e d in that the transmitter and receiver antennas (3, 4) are arranged directly opposite each other on either beating disc (1, 2).

9. Arrangement according to any of the claims (6-8),
c h a r a c t e r i z e d in that it comprises a distance gauge (5) for measuring the distance between the beating disc (1, 2) and possibly a gauge for measuring the conductivity for electric current in the suspension.

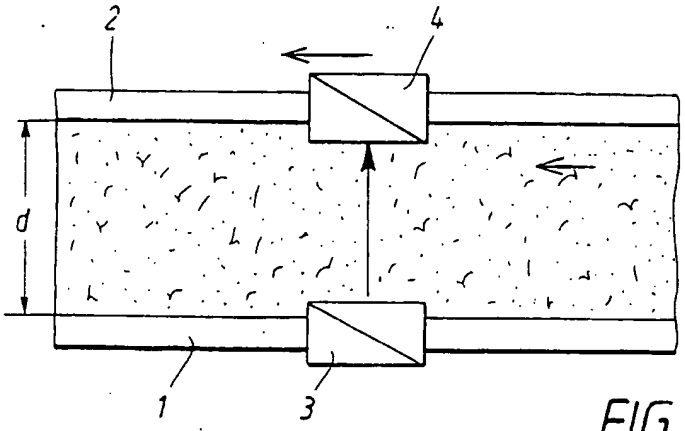

FIG. 1

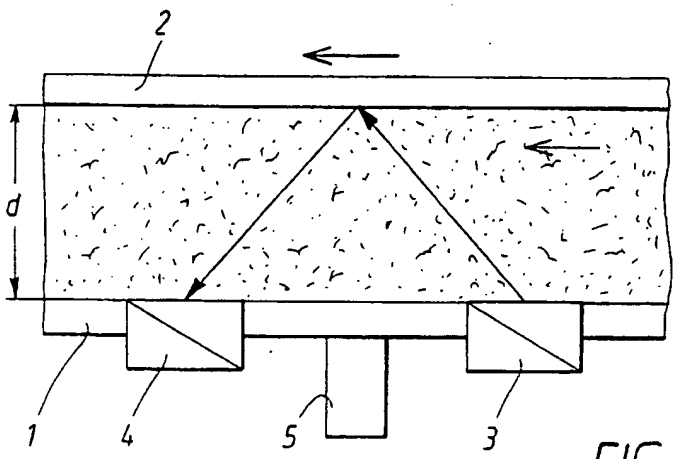

FIG. 2

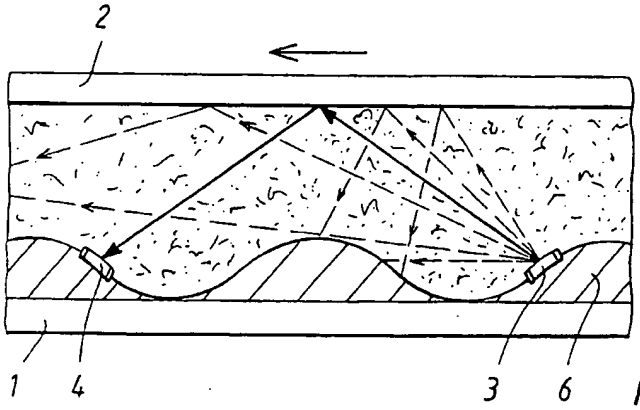

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/01153

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G01N 22/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G01N, D21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0619485 A1 (KABUSHIKI KAISHA TOSHIBA), 12 October 1994 (12.10.94) ---	1-9
A,P	Derwent's abstract, No 97-516566/48, week 9748, ABSTRACT OF JP, 9243575 (TOSHIBA KK), 19 Sept 1997 (19.09.97), abstract --- --------	1-9

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

27/07/98

International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0619485 A1	12/10/94	CN 1105123 A	12/07/95
		JP 6288937 A	18/10/94
		US 5502393 A	26/03/96